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TRAPS FOR THE JAPANESE BEETLE AND HOW TO USE THEM[1]

By F. W. METZGER, *associate entomologist, Division of Japanese and Asiatic Beetles, Bureau of Entomology*

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INTRODUCTION

Traps designed to catch Japanese beetles have been in use for several years. Large numbers of this insect have been caught and destroyed by this means when the traps have been correctly placed and properly operated. Experience and observation have shown, however, that results are often disappointing to users of traps when the correct procedure and equipment are not employed. The purpose of this publication is to discuss the types of traps found to be most effective in catching beetles and to point out the proper method of placing and operating these devices to obtain the most satisfactory results.

VALUE OF TRAPS IN ISOLATED OR LIGHTLY INFESTED AREAS

Traps are particularly valuable in localities where the beetle infestation is light, especially at points some distance from the heavily infested area. In these situations there is no possibility of traps increasing the number of beetles present by attracting them from areas where this insect is more abundant, and consequently little or no danger of injury to fruit or foliage is occasioned by their

[1] This publication is a revision of and supersedes Miscellaneous Publication No. 147 entitled "Trapping the Japanese Beetle."

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use. The advantages, on the other hand, are most important. Naturally, the control of any insect pest is much more readily brought about when the insect is present in small numbers. One female beetle captured under such conditions is likely to prove to be of more importance than several thousand caught a few years later when the infestation has reached its height. In localities where only a few beetles are present, a diligent search will often fail to reveal even a single individual, whereas the presence of beetles may be determined by the use of traps properly placed, with little effort and expense on the part of anyone. The easiest way to capture beetles under such conditions is by the use of traps, and, while a female beetle may have laid some eggs before being captured, it is almost certain that egg-laying has not been completed.

The user of traps in a lightly infested area should not become discouraged if he captures only a few female beetles in a single season, because these, if not caught, would have been capable of producing a definite increase in the beetle population the following summer.

VALUE OF TRAPS IN AREAS OF HEAVY INFESTATION

Every year many individuals in the area heavily infested by the beetle inquire, "Shall I use traps, and if so, what may I expect to gain by their employment?" This question must be considered from several angles, and the prospective location of each trap presents an individual problem.

Traps have been used for several years, and many millions of beetles have been captured annually. Many users of traps have been entirely satisfied with the results and have stated their belief that the traps did not increase the beetle infestation on their properties. In direct contradiction to this other persons have reported a greater infestation with traps than without them, with an increased amount of injury to fruit and foliage. Doubtless both results have been obtained and were caused, to a considerable extent, by the type and placement of the equipment used, and also by local conditions.

Another belief which is widespread is that a trap has the power to attract beetles from a considerable distance. The attractive power of a trap is determined very largely by atmospheric conditions, one of the most important of which is the velocity of the wind. Air currents are necessary to carry the attractive vapors, and in a light breeze the zone of attraction is comparatively small.

If a trap is so located on a property that the odor of the attractants is carried across an open field (fig. 1, *B*), it is quite possible that beetles may be attracted from a distance of from 300 to 500 yards, under favorable atmospheric conditions. The zone of attraction is comparatively limited, however, in residential sections (fig. 1, *A*), where trees, houses, and other buildings tend to deflect or impede air currents. In such cases traps attract beetles only from the immediate vicinity of the property on which they are located.

It is obvious that 10 traps, for example, in a town of 5,000 inhabitants will have little or no effect in reducing the beetle infestation of that locality. The only possible advantage will be purely local. On the other hand, the larger the number of traps employed

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the greater will be the effect on the beetle population in the community. Many campaigns have been carried on against insect pests. Those which have been successful are the ones in which proper cooperation was obtained. The same situation exists with respect to Japanese-beetle campaigns.

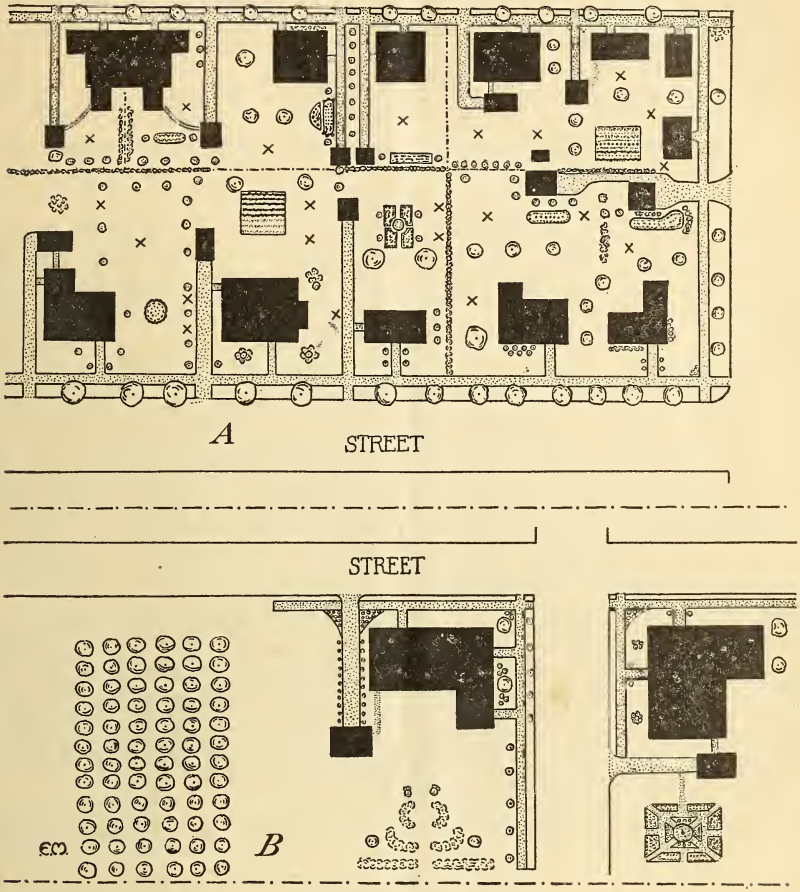

FIGURE 1.—*A*, Diagram of an area on which traps can be used advantageously (*x*'s indicate proper locations for traps when the prevailing winds are from the right; *B*, diagram of an area on which the use of traps is sometimes impracticable, particularly in a locality where the prevailing winds (from the right) would carry the odor of bait toward the orchard and thus probably draw more beetles to the shrubbery than would normally be present. (Scale: 1 inch equals approximately 90 feet.)

Individuals living in the zone of greatest beetle abundance should not rely upon traps alone to protect favored food plants from the attack of this insect. Protection of foliage is best obtained by the use of sprays applied in accordance with the recommendations of the Japanese-beetle laboratory of the Bureau of Entomology. Such

sprays, however, are primarily intended to protect foliage and are much less effective from the standpoint of materially reducing the number of beetles present.

GENERAL INFORMATION REGARDING TRAPS

There are certain essential requirements which must be fulfilled if the best results are to be secured in trapping Japanese beetles. These requirements are as follows:

Obtain a trap similar to one of the types described in this circular and make certain that the bait corresponds as nearly as possible to the specifications given on page 9. Do not accept anything alleged to be "just as good." Select a location where the wind will carry the attractive odor in such a manner that the beetles will tend to be drawn from plants to the trap. Beetles always fly against the wind toward a trap. Do not place a trap so close to plants that the beetles which are attracted have an opportunity to alight on the foliage; a distance of not less than 10 feet or more than 25 feet from the nearest trees, shrubs, or flowering plants is most satisfactory.

As shown in figure 1, *A*, there are one or more good locations for a trap on each of the properties in the area illustrated. Usually, however, one trap near each residence is sufficient where the lots average 50 feet in width. Two or three traps can sometimes be employed to advantage on the larger properties which are also illustrated in figure 1, *A*. On properties with grounds of considerable extent the foregoing rules for locating traps should be applied. Many such estates have large open areas, and in such situations 9 or 10 traps per acre can be used to advantage.

Locate each trap so that it will be in the sun for as many hours during the day as is possible; beetles rarely enter a trap in the shade. The trap should not be placed on the ground, but should be supported by a post or a standard so that the top of the funnel is from 3 to 4 feet above the ground. The standard should always be equipped with an arm so that the trap will hang free and the beetles will not be blocked off on one side by the post.

TYPES OF TRAPS WHICH ARE GENERALLY UNSATISFACTORY

Certain types of traps will capture beetles, but results obtained with them have been generally unsatisfactory. Such, in particular, are devices with small funnels (2 to 3 inches in diameter), baffles with only one wing, and room for only a small amount of bait. Such traps are cheap, but they are usually poorly constructed and seldom last more than 1 or 2 seasons. The opportunity for beetles to be captured is limited because of the small opening at the mouth of the funnel. In addition, the attractive aroma of the small amount of bait used is dispersed over a very limited area. An even more serious objection to the use of these traps in beetle-control work is that the user generally becomes discouraged with the poor results obtained and is prone, thereafter, to belittle any advantage to be obtained by using traps.

One argument has been advanced in favor of cheap traps, selling, for example, at 10 cents each; this is that 5 such traps could be

purchased for the cost of one 50-cent trap, and as many beetles would be captured with the 5 as with 1 trap of the more expensive type. This theory has never been substantiated, and there are, moreover, obvious disadvantages involved. The five traps would all require beetle containers and standards, which would increase the cost considerably above that of the single one. In addition, five times as much labor would be required in caring for the smaller traps as compared with the large one. This is an important factor because the layman, while he may be interested in trapping the beetle, is likely soon to tire of the work if it becomes laborious.

DESCRIPTION OF TWO SATISFACTORY TYPES OF TRAPS

TYPE A, TRAP WITH SOLID FUNNEL

The trap illustrated in figure 2 was devised at the Japanese-beetle laboratory and is believed to be one of the most effective types. It can be manufactured inexpensively and sold at a reasonable price and will give very satisfactory results. The device consists of a funnel which is 7¼ inches in diameter at the top and three-fourths inch at the bottom and 7½ inches deep. Figure 3 shows a cross section of this trap, with dimensions. The baffle is 6 inches high and is formed by two pieces of metal fitted at right angles. It extends 4 inches above and 2 inches below the top of the funnel, being securely fastened to the latter by soldering or riveting. The funnel and baffle are constructed of 30-gage dull galvanized iron.

The edges of the baffle extend to the rim of the funnel, but the central section is cut away to accommodate the bait container. The bait container is 6 inches long and 2 inches in diameter, and is constructed of 30.5-gage perforated tin plate. The perforations may range in number from 64 to 121 per square inch of surface. The container is soldered to the baffle at the top and bottom of each of the four wings. The ends of the container are closed by tin covers with sides one-fourth inch high, the lower being soldered in place, while the upper one is removable, to permit the insertion of bait. The lower cover prevents liquids, which may drip from the wick, from going into the funnel. This type of bait container permits the use of either a solid bait or a liquid bait which is vaporized from a bottle by means of a wick.

BEETLE CONTAINER

The beetle container is attached to the trap by means of a screw cap for a standard mason jar soldered to the funnel 1 inch above the lower end. An ordinary mason jar may be used as a container, the size of which will depend upon the degree of beetle infestation. A 2-quart jar is the largest size that can be advantageously employed, except in areas of very heavy infestation. Such a container, when filled, will hold approximately 6,600 beetles. A smaller jar may be used where only a few beetles are present.

The jar container should have a small perforation in the bottom to permit the escape of water; otherwise it will soon fill up in wet weather. The opening should not be too large, however, as it would offer the beetles a ready means of escape. One method of

making an outlet in the bottom of a glass jar has been developed at the Japanese-beetle laboratory. By this procedure a slit is made in the jar by a 60-grain, 6-inch electrolon wheel, one sixteenth of an inch thick. This wheel cuts best when running at a speed of 10,000 linear feet per minute. To cut the slit it is necessary to hold the bottom edge of a jar against the wheel with moderate pressure while a fine stream of water is directed at the point where the cut is to be made. Water should always be used; otherwise the jar will crack immediately.

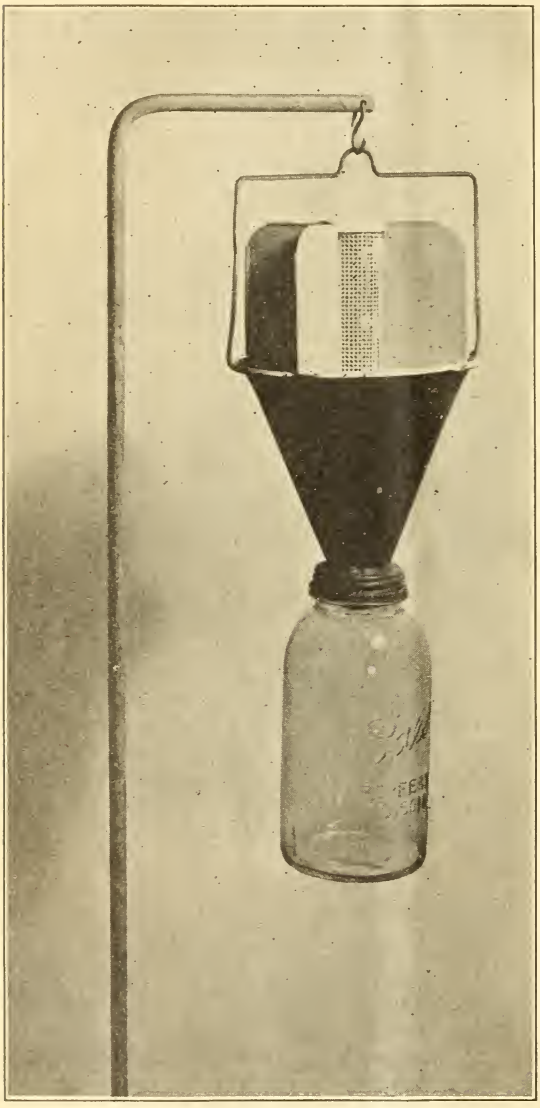

FIGURE 2.—Japanese-beetle trap with solid funnel, suspended from a standard.

Under conditions of heavy infestation, where it is necessary to empty a 2-quart jar several times a day, larger containers may be employed. These may be made of either glass or perforated metal in various sizes.

MEANS OF SUSPENSION

The trap should be suspended from a standard by means of a bail handle inserted through two holes one half inch from the top of the funnel. The handle, including a ¾-inch loop, extends 6¼ inches above the upper rim. The bail is made of 10-gage galvanized iron wire.

Another method of suspending the trap is by means of a smaller bail handle inserted through two holes one fourth of an inch from the top of the baffle. If this method is used, extra care should be taken in fastening the baffle to the funnel, as all the weight of the trap will then be carried by the baffle.

TYPE B, TRAP WITH OPENINGS IN THE FUNNEL

Many of the beetles attracted to the trap previously described strike the funnel and, while many are captured later, some are lost. A trap with openings in the funnel (fig. 4) reduces the number lost in this way. This trap is similar to trap A, with the exception of the holes in the funnel and a slight modification of the baffle. In the funnel there are four openings 2½ inches wide at the bottom and 2½ inches high. In order to conform to the shape of the funnel the apertures are made 4 inches wide at the top. The baffle is extended to the bottom of the aperture, or 4½ inches into the funnel.

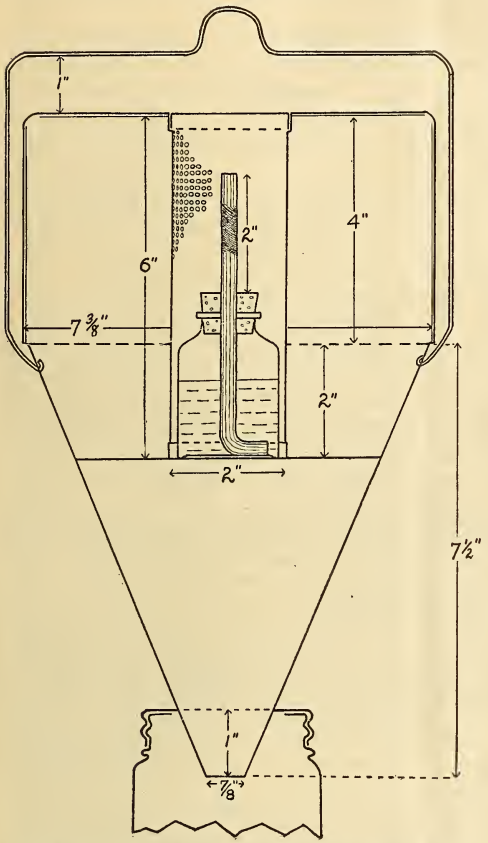

FIGURE 3.—Cross-section of Japanese-beetle trap without openings in funnel, showing dimensions.

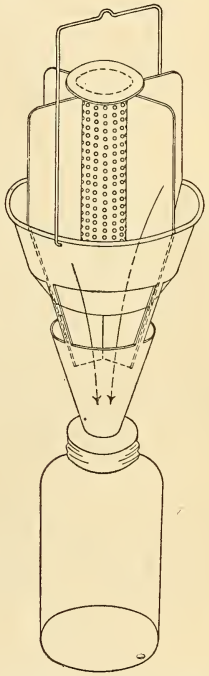

FIGURE 4.—Japanese-beetle trap with side openings in the funnel.

Each flap is 1½ inches long and projects inward at an angle of 35° with the side of the funnel. The diagonal edges of the flaps engage the wings of the baffle. This part of the construction is most important. If the flap does not fit tightly against the baffle at these points, beetles entering from above will find a foothold before being precipitated into the beetle container, and many will probably escape.

This trap will capture a larger percentage of the beetles that are attracted than will the trap without openings in the funnel. At present, however, the trap with openings may not be as readily available commercially as the earlier type.

PAINTING THE TRAPS

The exterior of the trap funnel is painted green, light green being most satisfactory. Medium green may be used, but the darker shades should be avoided. The entire baffle, bait container, and the inside of the funnel are painted white. Traps painted in this manner capture many more beetles than do traps painted entirely white or green. Traps painted aluminum color will capture a large number of beetles, but tests have shown that this color is not so effective as the recommended green-and-white combination.

It has been found that newly painted traps that have a glossy surface capture more beetles than traps that have not been painted for one or more seasons. Because of this it is advisable to paint traps with a material that will give them an appearance as shiny as possible. Another desirable quality of a suitable paint is resisting heat without cracking or fading.

The geraniol in the bait causes the paint on the bait container to peel off, as this material is an alcohol. For this reason it is desirable to use an alcohol-resistant paint on the bait container.

SUSPENDING THE TRAP FROM A STANDARD

Figure 2 shows a trap suspended from a suitable standard. This is a $\frac{7}{16}$-inch galvanized iron rod, 7 feet long, with an 8-inch arm at the upper end. A $\frac{1}{4}$-inch hole is bored 1 inch from the outer end of this arm. The trap may be suspended by passing a wire hook through this hole and around the handle of the trap. Standards of ordinary iron soon become rusty; standards of galvanized iron, although somewhat more expensive, last much longer. A standard with a pointed tip is a great convenience, because it can be pushed into the ground much more readily than one with a blunt end.

COST OF TRAPS

These traps are believed to be two of the most satisfactory traps developed so far. The retail price varies considerably and depends upon the kind of material used in construction. They have sold for $1 to $1.50 when purchased singly, with a considerable reduction when bought in quantity. This price range may or may not include a standard or a beetle container.

With reasonable care a substantially made trap will last for several years, and a number which have been employed at the Japanese-beetle laboratory for 7 summers are apparently as good as new. Satisfactory traps are on sale at many hardware and seed establishments in New Jersey, eastern Pennsylvania, and northern Delaware. They are also carried by some department stores in the Philadelphia area.

WHEN TO PLACE TRAPS

Seasonal variation and the latitude of the area in which traps are to be used make it impossible to set a definite date for placing traps in the field or removing them at the end of the summer. During the past several years they have been used effectively between June 25 and September 1 in the vicinity of Philadelphia. North of the Phil-

adelphia area the beetles may emerge several days later. Farther south, at Norfolk, Va., for example, the season is much earlier and usually extends from June 1 to August 15. The best rule to follow is to place traps as soon as beetles appear and to allow them to remain as long as the insects are present.

BAIT

Beetles are drawn to traps because the geraniol and eugenol present in the bait are attractive to them. The Japanese-beetle laboratory has tested a great many other substances as attractants for the beetle, but none has been found so attractive as the combination of materials mentioned above. Geraniol should not be confused with geranium oil; the two substances are entirely different compounds, and the geranium oil is only slightly attractive to the beetle. Citronella oil is not so attractive to the beetle as is geraniol and should not be used. Eugenol has an odor similar to that of clove oil, but is much stronger than clove oil and should always be employed.

LIQUID BAIT CHEAPER AND MORE EFFECTIVE THAN SOLID BAIT

Solid bait is very effective in drawing beetles to traps, but it is bulky and, when exposed to the air, gradually decreases in attractive power as the attractants are vaporized. It is now possible, however, to use a cheaper and somewhat more effective form of bait that will maintain a constant attraction for the beetle over a considerable period. This bait consists of the attractants in liquid form used at the rate of 1 part of eugenol to 10 parts of geraniol.

When bait is used in liquid form the attractants are placed in a bottle having a capacity up to 1½ ounces. This bottle should not be more than 1¾ inches in diameter; otherwise it will not fit in the bait container. The height should not be greater than 3 inches; otherwise the wick will come in contact with the top of the container. Figure 3 shows a bottle of the correct size resting in the bait container; this bottle is supported by the sides of the container so that it will not be easily spilled. In the older traps, where the bait container is within a cylinder, the bottle can be placed in the receptacle without difficulty.

The attractants are vaporized from the bottle by means of a wick. Satisfactory results have been obtained with one type of wick made of cotton, $\frac{3}{16}$ to ¼ inch in diameter, with a woven cotton sheath covering from 5 to 12 inner fibers which run lengthwise. The wick is inserted through a cork into the bottle so that from 2 to 2½ inches of the wick is exposed. A greater length of wick above the cork will cause the attractants to evaporate too rapidly, while a shorter one will result in the capture of fewer beetles.

This bait is effective as long as any liquid remains in the bottle, and 1½ ounces will probably last 5 to 7 weeks, depending on weather conditions. If any of the material remains at the end of the season, it may be stored and used the following year, provided it is kept in a tightly stoppered amber-colored glass container. Geraniol and eugenol stored under these conditions will not deteriorate as far as attractiveness to the beetle is concerned.

COST OF LIQUID BAIT

The wicking is inexpensive, but would probably have to be replaced each year, unless the traps were placed in an area exceptionally free from dusty roads, factories, and steam railroads. The bottles and corks, while involving a considerable initial expenditure, would probably last over several seasons, making the yearly outlay small. The actual bait costs less than the solid bait (described on this page), since the bran, glycerine, and molasses are omitted.

Geraniol can be obtained in small quantities from chemical supply houses and direct from the manufacturer in larger quantities. Retail prices vary considerably, but in 1933 this material sold for $1.50 to $3 in pound lots. Various grades of geraniol are on the market, and one of not less than 70-percent purity should be used.

Eugenol can usually be obtained from the same houses that sell geraniol, and a grade of U.S.P. standard should always be employed. During 1933 the price of this material in pound lots approximated that of the purer grades of geraniol.

SOLID BAIT

The solid bait formerly recommended is more expensive to use and is slightly less attractive to the beetles than the liquid bait. As a rule it should be replaced every 2 weeks. It may become moldy because of excess moisture, however; in that case it should be changed at once.

There are many traps still in use which are not adapted for liquid bait. The formula for the old type of bait is as follows:

FORMULA FOR SOLID BAIT

Geraniol (at least 70 percent pure)	15 grams (4 teaspoonfuls).
Eugenol (U.S.P.)	1.5 grams (½ teaspoonful).
Bran	75 grams (1½ cups).
Water	13 cubic centimeters (1 tablespoonful).
Molasses (good table grade)	39 cubic centimeters (2½ tablespoonfuls).
Glycerine (chemically pure)	6 cubic centimeters (1½ teaspoonfuls).

Total weight approximately 150 grams, or one third of a pound.

Bait prepared according to the above formula is still made by a number of companies and individuals. It is usually sold in cans of various sizes, and many dealers provide sufficient material for one baiting with each trap.

The directions for the preparation of this bait are: First add the water and glycerine to the molasses and shake vigorously. Then pour the liquid into the bran, stirring constantly. Add the geraniol and eugenol and stir until the bran is thoroughly mixed with the liquid.

It is hardly worth while to mix bait at home for only one trap, but when several are operated at one time the bait materials may be purchased in quantity, with a consequent saving. This bait should be kept in a closed container and stored in a room free from dampness until used. The cost of solid bait varies considerably and may range from $1.25 to $2 per pound.

REMOVING BEETLES FROM TRAPS

As beetles are very active during the day, it is best to remove them from a trap after 7 p.m. or before 8 a.m., because between these hours they seldom fly and very few are likely to escape. In collecting beetles from a trap with a jar container, simply unscrew the jar and quickly empty it into a pail containing water and a small quantity of kerosene or gasoline, or very hot water alone. This will kill the beetles in a very short time. If the beetles from several traps have been emptied into a pail, the mass should be stirred to insure wetting the insects. The container should be kept covered until all are dead.

When a jar container is emptied after a warm day a large number of the beetles therein are already dead and, indeed, there are occasions when all appear to be lifeless. This should not be taken for granted, however; a killing agent is the best insurance for complete mortality of trapped beetles.

Each trap should be emptied at least every other day when large numbers of beetles are captured, to avoid decomposition of the insects. When jars having no outlet in the bottom are employed, it is also necessary to empty them after a rain, as a considerable quantity of water will collect in them and will hasten the decomposition of any beetles present. The jars should also be washed occasionally, because they will soon become dirty from beetle excrement and the odor will decrease the attractiveness of the bait. Never pour gasoline or kerosene into a jar without washing it thoroughly afterward, as the presence of any foreign odor will result in a greatly diminished beetle catch.

After the beetles have been killed they should be disposed of as soon as possible. Whenever convenient, burying is a most satisfactory means of disposal. Burning, even with the aid of oil or kerosene, does not entirely consume a considerable quantity of beetles, and the combustion is accompanied by a most disagreeable odor. If the beetles are to be disposed of with trash they should be kept in a closed container, unless they are to be carried away within a few hours after they have been killed.

Beetles killed with hot water have been fed to chickens with no apparent ill effects. They have also been used as fertilizer, being thinly broadcast over gardens and fields. In the absence of any experimental evidence regarding their value for these two purposes, however, no recommendations are made.

WHERE TRAPS AND BAIT CAN BE OBTAINED

The Japanese beetle laboratory does not manufacture or sell traps and bait. However, information regarding manufacturers of all equipment and materials necessary for trapping this insect can be obtained from the Japanese beetle laboratory of the Bureau of Entomology at Moorestown, N.J.

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